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CFD Modeling of two-phase flow of cryogenic fluids in the Slug Flow regime in a Microchannel

Content :

Microscale flow boiling is currently the most promising cooling technology when high heat fluxes have to be dissipated. Microscale two-phase flow occurs in internally cooled superconductors (CICC, Swiss Conductor, Euratom Conductor), Compact heat exchangers (like NMR), Micro heat sinks, Micro Joule-Thompson cooling devices, Evaporator and Condenser sections of micro vapor compression cycles. For the most part of the flow in a microchannel, the regime of flow is slug flow. Thus the understanding of the thermal and hydrodynamic features of the flow plays a fundamental role in the design of microchannel based devices. Even with recent, current flow visualization techniques are still inadequate to capture the small scales involved in the flow. The recent advances in the multiphase CFD techniques provide valuable insight into the complex process of flow boiling in microchannels. The achievement of a reliable and robust numerical framework allows a better understanding of the bubble and flow dynamics induced by the evaporation and makes possible the prediction of the wall heat transfer trends

The objective of the current study is to perform CFD investigation of flow boiling in the slug flow regime in a microchannel. Cryogenic fluid Nitrogen is the fluid of interest. The volume of Fluid technique coupled with Level Set method is used to solve the flow field. In order to reduce computational time, the axisymmetric formulation is used for flow modeling. Vapor and liquid phases are treated as incompressible and in laminar flow. Flow equations are solved using commercial CFD package Ansys fluent. The flow equations are written for a single phase flow. The interfacial mass transfer is through phase change is implemented using User Defined Functions in Fluent. Effect of flow parameters like, mass flux, heat flux, channel diameter is studied.

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